Human Effectiveness Directorate

USAF Scientific Advisory Board
1999 S&T Program Review
Distributed Mission Training Technology

Air Force
Research Laboratory | AFRL
Science and Technology for Tomorrow's Aerospace Force

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Maj Justine Good
Warfighter Training Research Division

Overview

- **The AF Technology Investment Strategy (TIS)**
- **The Five Major DMT Technology Areas**
  - **AFRL/HEA's DMT Technology Program Embedded**
- **DMT Technology Challenges (some examples)**
- **AFRL/HEA's Major Milestones & Exit Criteria**
- **AFRL/HEA's Focus on the EAF Vision**
- **Success Stories**
- **Air Force Association Technology Exposition, 13-15 Sep 99, Marriott Wardman Park, Wash DC**

AF DMT IPT
Senior Steering Group

Air Staff	MAJCOM	Others
AF/XO (Chair)	ACC/XO	AC2ISRC/CC
AF/XOC	AETC/DO	AFR/REO
AF/XOI	AFSOC/DO	AFRL/CC
AF/XOO	AFSPC/DO	ANG/DO
AF/XOP	AMC/DO	ASC/CC
AF/XOR	PACAF/DO	SAF/AQ
AF/XPP	USAFE/DO	SAF/AQQ

TIS Development Goals

- **Develop a TIS to support MAJCOM training implementation plans (TIPs) AND THE MISSION!**

- **Define technologies that:**
  - **Enhance AF mission effectiveness**
  - **Provide an environment that enhances the Core Competencies**
  - **Reduce life cycle costs and development time while increasing utility, sustainability and reuse**
  - **Improve training system effectiveness, availability and reliability**

- **AF TIS provides feedback for DMT domains to determine**
  - **Technology needs**
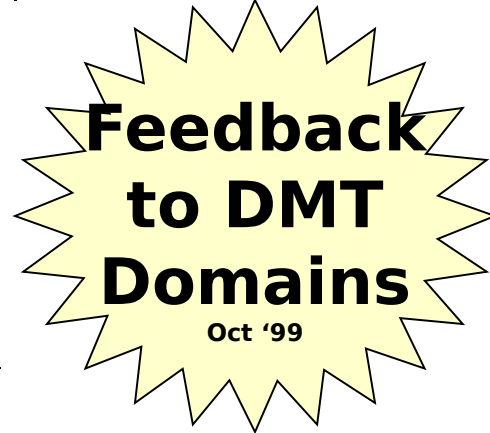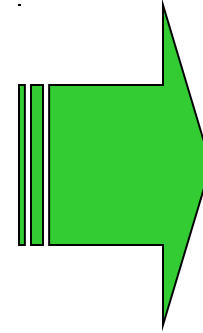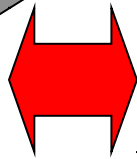 - **Cost estimates for POM processes**

TIS Development Process

Top-Down Analysis

Mission Requirements, Mission Essential Task List, Joint Task List, AF DMT Trng Implementation Plan

Other DoD Plans Review

DTAP, DARPA, STRICOM, NAWC, DMSO, DISA

Users
Aug '98

TIS

Feedback to DMT Domains
Oct '99

Bottom-Up Analysis
Existing Technology and Acquisition Pgms
Technical expertise

TIS Development Process

Top-Down Analysis

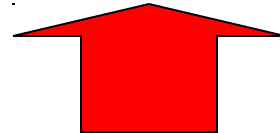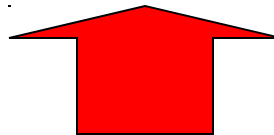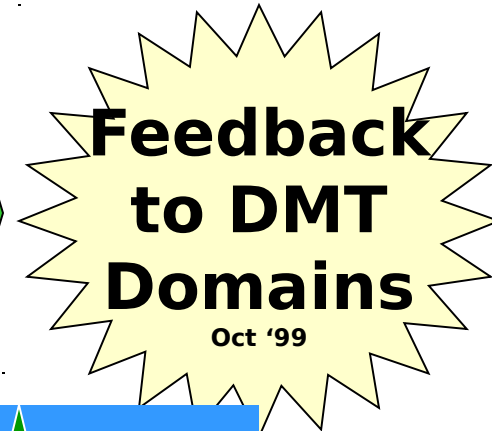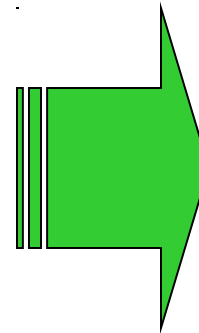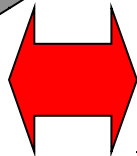Mission Requirements, Mission Essential Task List, Joint Task List, AF DMT Trng Implementation Plan

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Aug '98

TIS

Feedback to DMT Domains

Oct '99

AFRL/HEA DMT R&D

Bottom-Up Analysis

Existing Technology and Acquisition Pgms
Technical expertise

The TIS . . .

- **Represents <u>concurrence from users</u>**
- **Represents rough order of magnitude costs**
- **Is a mix of R&D and monitoring of technology and technology applications for DMT**
- **Is intended to feed into 6.4 programs**
- **<u>Does not include implementation costs</u> (6.4)**
- **Is an on-going process of technology insertion and a plan for continuous improvement**
- **<u>Assumes that leveraging</u> of existing technologies and programs <u>is part of the investment strategy</u>**
- **Does not address apportionment of funding by MAJCOMs and higher - beyond the scope of TIS**

Air Force DMT
Five Technology Areas

Area 1: Training Systems Technology

Area 2: Information Technology

Area 3: Interconnection Technology

Area 4: Visual Technology

Area 5: Representation Technology

Training Systems Technology
Area 1

- **Advanced Distributed Learning**
  - **Courseware Development (C2, Fighter Weapons School)**
  - **Air University Model (Virtual University)**
  - **Data Mining/Warehousing**
  - **Education/Outreach Program**
- ✦ *Cognitive Modeling*
- **Control System Development**
- *Cueing (Sensation, Perception, Deliberation, Action, Interaction)*
- **Event Management**
  - ✦ **Design and Planning**
  - **Event Execution**
  - **Distributed Brief/Debrief**
  - **After Action Review**
- **Performance Feedback/Measurement**
- *Training Strategies/Methods Evaluation*
- *Training Strategies/Methods Research*
- **Voice Interfaces**
  - **Automatic Speech Recognition**

Italics = Technical challenge

Information Technology
Area 2

- **Advanced Design & Development Methodology**
  - **Rapid Prototyping**
  - **Soft Prototyping (Reconfigurable Hardware)**
  - **Design and Development Security**
  - **Embedded/Design Languages**
  - **Prototyping Tool Kits**
- **Advanced Distributed Learning Information Systems**
- ✦ ***C4ISR Systems***
- **Data Mining**
- **Embedded Digital Signal Processor Applications**
- ***Image Processing*** *(C2, Real Time Data Fusion)*
- **Information Based Development**
  - **Standards Based Design**
  - **Common Operating Environment**
  - **Common Warfighting Data Libraries**
  - **Distributed Component Technology Data Warehouse**
- ***Real Time Intelligence Data Fusion***

*Italics = Technical
  challenge*

Interconnection Technology
Area 3

- ✦ ***Data Links***
  - ✦ **TADL, SADL, SATCOM, TIBS**
- • **Embedded Solutions**
  - – **Versa Module Eurocard (VME) Bus**
  - – **Personal Computer Interface (PCI)/Compact PCI**
- • **Heterogeneous networking environment**
  - – **Open Standards Interface (OSI)**
  - – **Network to Network Interface (NNI)**
- ✦ ***High Level Architecture (HLA)***
- ***Multilevel Security (MLS)***
  - **Multiple Levels Security**
  - **Dynamic Security**
  - **Virtual Channels, Virtual Local Area Networks (LANs)**
- **Networks**
  - **Dynamic Bandwidth**
  - **GNIE, NIPRNET, SIPRNET, Supernet, DTT, etc.**
  - **High Speed Wide Area Networks**
  - **ATM, Gigabit Ethernet, Wideband, IP**
  - **Latency Research**

Italics = Technical challenge

Visual Technology
Area 4

✦ ***Image Generators*** **(IGs)**
  - ✦ **Personal Computer (PC)-IGs**
  - **Night Vision Devices**
    - **Multi-Sensor Generators**
    - **Physics-Based Rendering**
- ***Visual Displays***
  - **Microlaser Projector**
  - **Helmet Mounted Display (HMD)**
  - **Tracker Technology**
  - **3-D Monitors**
  - **Screen Materials**
  - **Virtual Reality (VR)**
  - **Target Generation Unit**
  - **Visual Interface Unit**
  - **Perceptual Research**

*Italics = Technical challenge*

Representation Technology
Area 5

- Computer Generated Forces
- Conceptual Model of Mission Space (CMMS)
- *Correlated Multi-Spectral Data Bases*
  - Natural Environment (WX, time of day, etc)
    - Cultural Features
    - Mobile Objects
    - Night Vision Goggles (NVG)
    - Infrared (IR) and synthetic aperture radar
- Intelligent Agent Design and Manipulation
  - Artificial Intelligence (AI)
- Semi-Automated Forces
- *Synthetic Environments*
  - Electronic Combat Environment
    - Integrated Air Defense System (IADS)
    - Electronic Warfare (tactics related)
  - Threat Systems
  - STAGE, SWEG, DIADS, JIMM
  - NASM, JSIMS, JMASS
- Weapons Effects Modeling

Italics = Technical challenge

Area 1 Training Systems Challenge
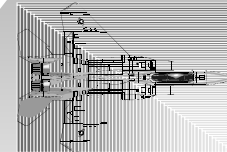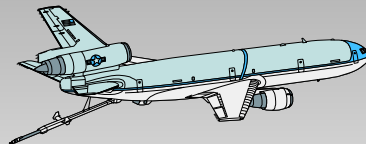## "How best can we use it?"
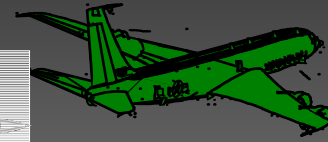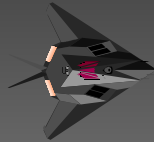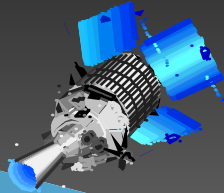
Training Needs Analysis

Training System Design

Training Device Design

Training System Evaluation

Effective and Efficient Individual, Team and Inter-team Training

Mission Success

Training Strategies & Methods Research
Training Strategies & Methods Evaluation

Area 2 Information Challenge
C4ISR Interfaces

- Global Communications
- Enhanced Target Identification
- Database Protection
- Information Management
- Secure, Survivable Networks
- Mass Data Storage/Processing

THEATER BATTLE MANAGEMENT

- Artificial Intelligence
- Advanced Displays
- Programmable/Interoperable Radio
- Reliable, Secure, Jam-Resistant Communications
- Advanced Mapping Tools
- Speech Translator/Enhancement

Command, Control, Computers, Communications, Intelligence, Surveillance, Reconnais

Area 3 Information Challenge
Multilevel Security

Higher Security Level

Firewall

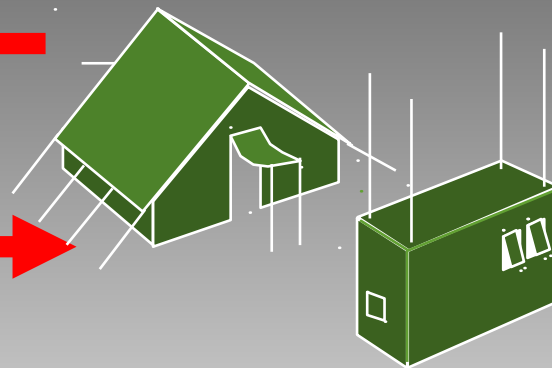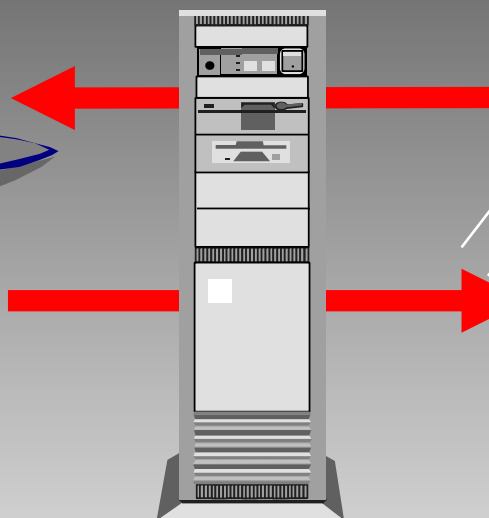**Lower Security Level**
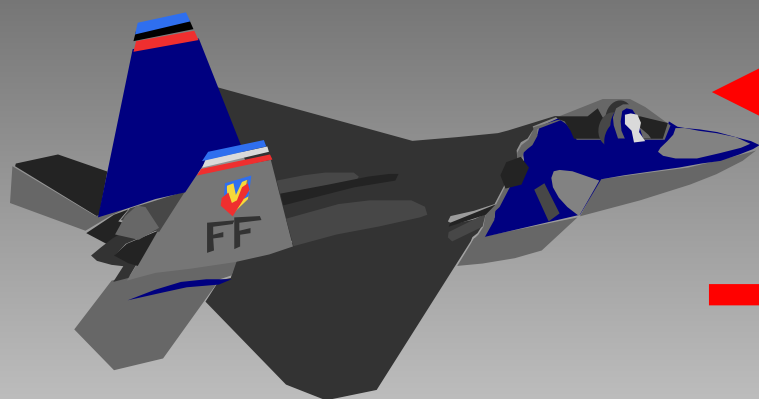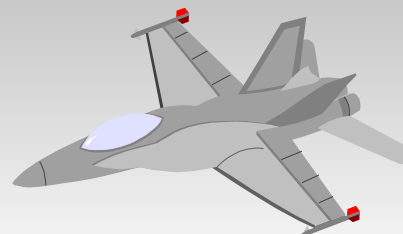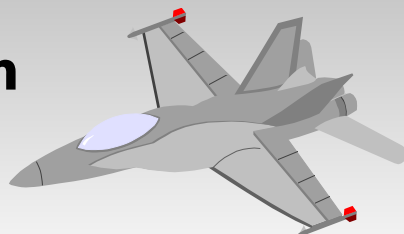
System High

System High

Area 3 Technology Challenge
Multilevel Security

- **Pursue solutions for multiple levels of classification over secure DMT networks**
- **Solutions for multiple single layers of different classifications over the same networks**
- **Create a system that maintains real-time, i.e. (60Hz)**
- **Never been done for real-time (60 Hz) high fidelity flight simulation**
- **Will affect joint service and coalition force training**
- **Industry admits that little is being done in this area**

Area 4 Visual Challenge
Microlaser Projection System

Solid State Microlaser Projector

AFRL/HEA Photo-realistic Development Database

Area 4 Technology Challenge
Microlaser Projection System

- **Current mission training issues / needs**
  - **20/20 visual acuity for targets not possible**
  - **Air-to-air and air-to-ground visual systems, in general, are low resolution**
  - **Current CRT-based systems at best are 1280x1024 (which is 1,300,000 pixels, legacy systems far lower)**
  - **CRT systems limited by spot size capability**
- **Innovative projection system design:**
  - **Direct-write microlaser, rear screen projected**
  - **Ultra-high resolution, increased contrast, excellent brightness (that could approach daylight), and significantly improved color gamut**

Area 4 Technology Challenge
Microlaser Projection System

- **Innovative projection system design:**
  - **Technical risk is high in spatial light modulation**
  - **Math required for 5120 x 4096 has never been done**
  - **5120 pixels x 4096 lines which = 20,000,000 pixels**
- **No image generation system is currently capable of producing 20,000,000 pixels**
- **Cost of the R&D is high**
  - **We have leveraged our investment in both approaches**
- **Two separate approaches underway with industry**
- **This is technology push!**

Area 5 Technology Challenge
Synthetic Environments

Off-boresight degradation

Real-time beam pointing

EWIR-level accuracy
- pulse & frequency agility
- scan pattern

Clutter bin maskin

Real Terrain Data (DTED Level 1)
Terrain-specific clutter (Surface code from DFA

Area 5 Technology Challenge
Synthetic Environments

- **Synthetic Environments should:**
  - **Facilitate man-in-the-loop threat simulation**
  - **Use DoD sources for validated models**
  - **Provide validated threat and friendly missile flyouts in their respective simulations**
  - **Use high fidelity aerodynamic and weapons models that stand the scrutiny of validation testing**
- **Main goal is to provide:**
  - **Modes of operation and behaviors that reflect the real world, and**
  - **Interactions with real-world effects, such as terrain clutter, water content of air etc.**
- **This approach also applies to "Blue Forces"**

DMT Technology Program
Major Milestones & Exit Criteria

	FY02	FY03	FY04	FY05	FY06	FY07
Training Systems Technology	Combat Msn Analysis Methods	COMACC F-16 TEE	Distributed Brief/ Debrief technology	Global Attack MECs	Cognitive Models for Instruction	Tng Strat Guidelines
Information Technology		CIS / TBMCS Integration	DB Development w/Live Intel Imagery		Roadrunner '06 Real-time Live-data Feed Test and Eval	
Interconnection Technology	Joint Research FOM		Final DIS / HLA MLS Accreditation	Dynamic Bandwidth Evaluation		MLS Concept Prototype
Visual Technology	Ultra Hi Res Microlaser	Thin Film Collimated Screen Design	Conjugate Optics Design	HMD laser Evaluation	Ultra Hi Res PC-based IG / Visual / Sensor Correlation Req	Ultra Hi Res Integrated Projector / IG
Representation Technology	Certified Dynamic Threat System	Dynamic DB Functional Spec		Pulse Level Processing of Ownship Radar		Real Time WX Feed

Real Time Intel / Data Feeds w/ Secure Connections

Certified Dynamic Threat System

Exit criteria:
- Validated Tng Guidelines for DMT
- DMT-S/C2 merge with DMT-A
- Ultra high resolution visual system
- Real Time Multi-spectral DB & EC environment

Our Focus on the EAF/AEF
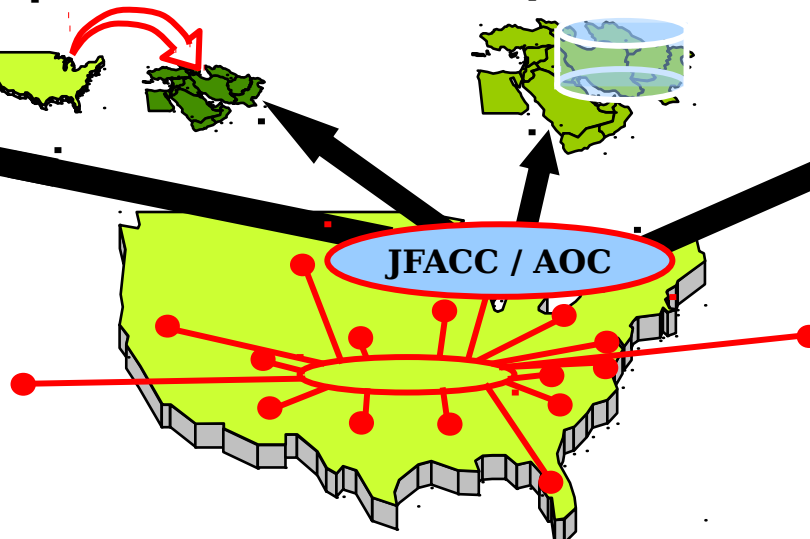## "Train to Task" Preparation Concept

Pre-Deployment Preparation

Deployment Preparation

Theater Operations Preparation

Sustainment Preparation

JFACC / AOC
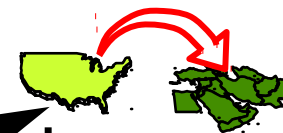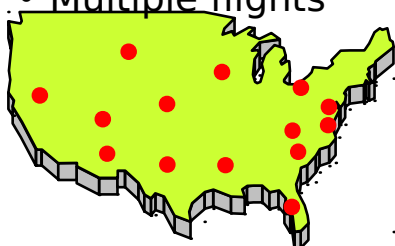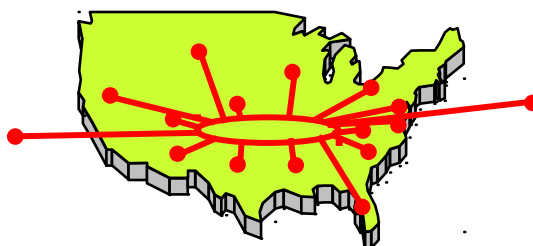
Theater specific individual unit training:
- Individual aircrew
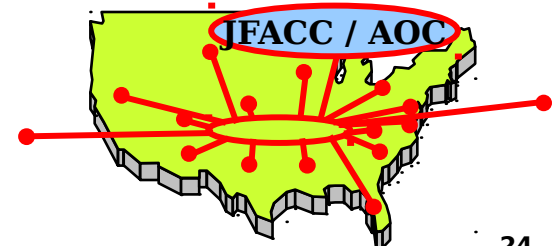- Single flights
- Multiple flights

Theater specific combined training:
- Multiple flights from different wings
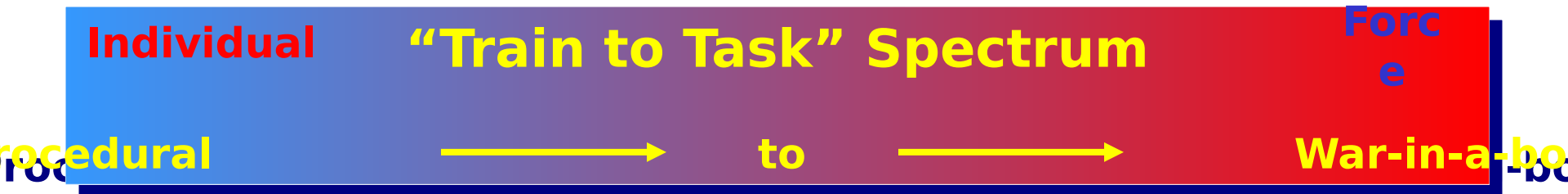- Full mission scenarios

Theater specific campaign training:
- Full mission scenarios & C
- Specialized theater ops

JFACC / AOC

Our Focus on the EAF/AEF
Mapping Technology to Mission

Individual   **"Train to Task" Spectrum**   **Force**

Procedural   →   **to**   →   **War-in-a-box**

	__F-15C__	__F-15E__	__F-16CJ__	__A-10__	__F-117__	__B-2__
__E-3__						
Individual WD	ACM	PGM	A-G	A-G	PGM	PGM
Team, Battle	DCA	OCA	SEAD	CAS	OCA	AI
Inter-team Mgmt		AI		SEAD	AI	SA
					SA	
Force PKG (also Joint and Coalition)	PKG	PKG	PKG	PKG	PKG	PKG

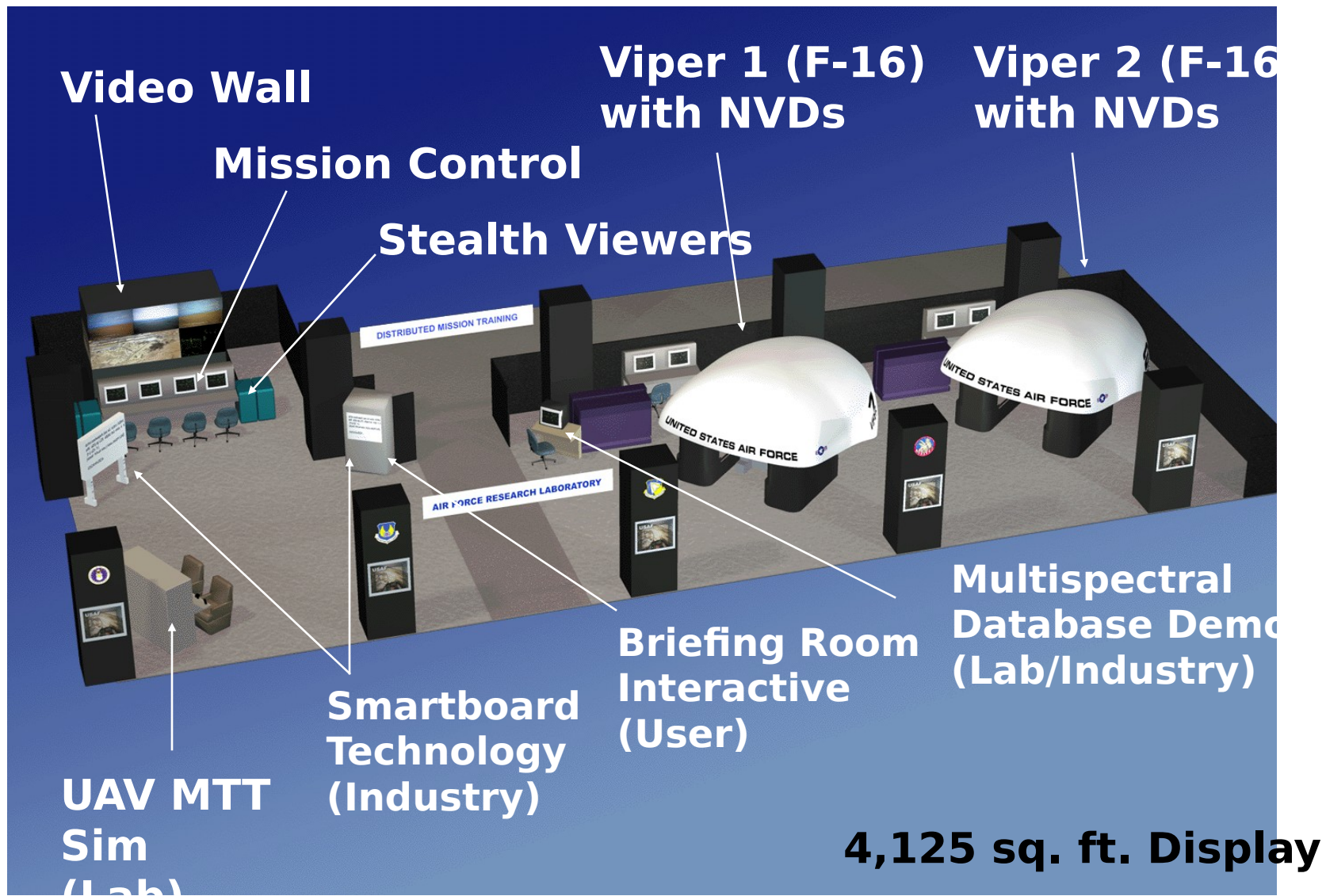ACM = Air Combat Maneuvering   PGM = Precision Guided Munition   A-G = Air-to-

Success Stories...

- **AFA 50th Anniversary in Las Vegas, NV, 4/97**
- **Roadrunner '98, 4-ship DMT Exercise, 7/98**
  - **Cannon AFB NM - Team A**
  - **Buckley ANGB CO - Team B**
  - **Iowa ANG - Team C**
- **Coyote '98, Multi-site HLA DMT Experiments, 11/98**
- **Cannon AFB Flight Lead Upgrade Pgrm begins, 1/99**
- **AFRL/HEA becomes voting member of HLA Architecture Management Group, 2/99**
- **AFRL/HEA becomes beta site for real-time HLA, 3/99**
- **AFA Technology Demonstration, Wash DC, 9/99**
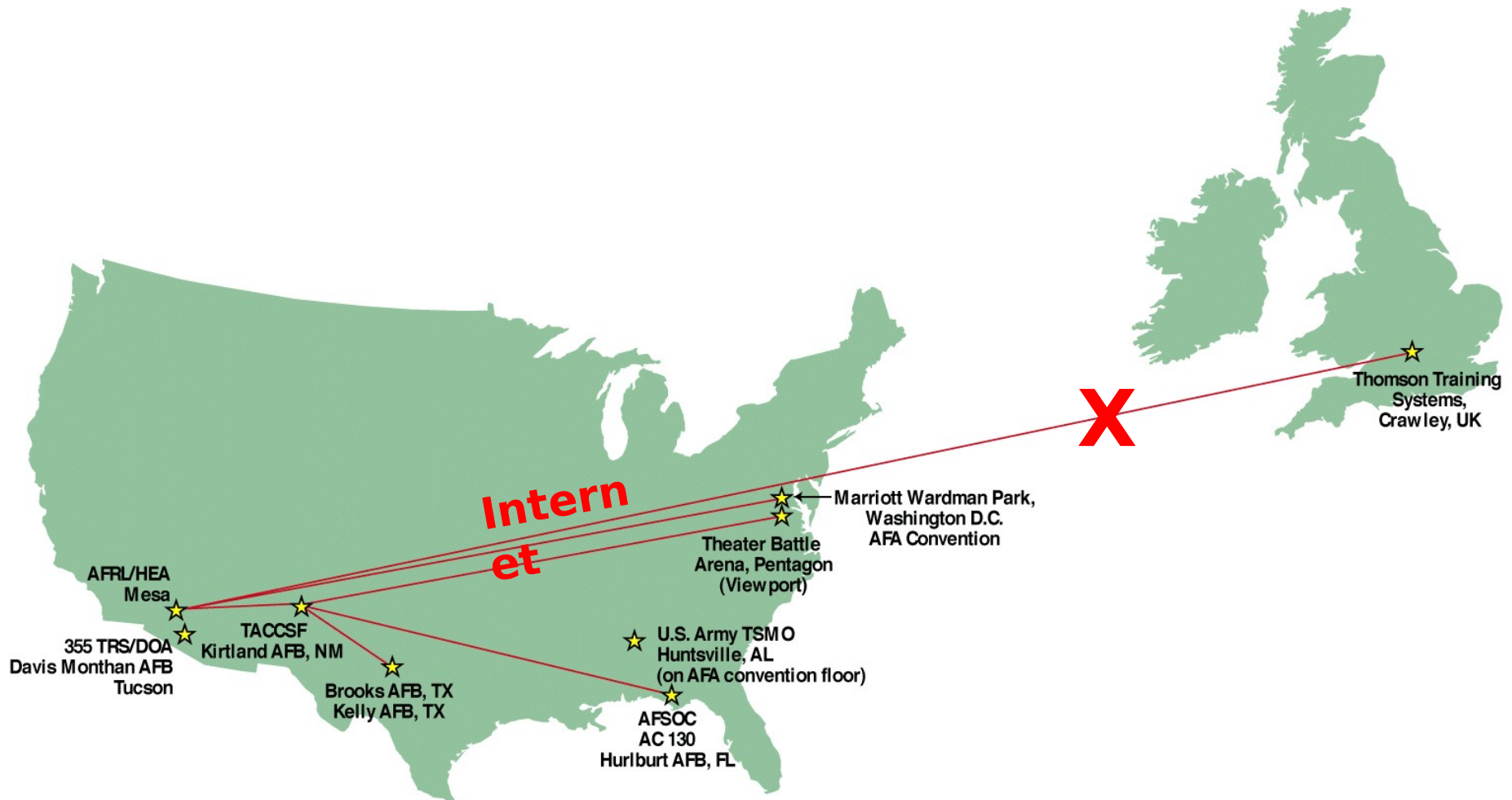
AFA Technology Expo '99
13-15 Sep 99, Wash DC

Video Wall

Mission Control

Stealth Viewers

Viper 1 (F-16) with NVDs

Viper 2 (F-16 with NVDs

Multispectral Database Dem (Lab/Industry)

Briefing Room Interactive (User)

Smartboard Technology (Industry)
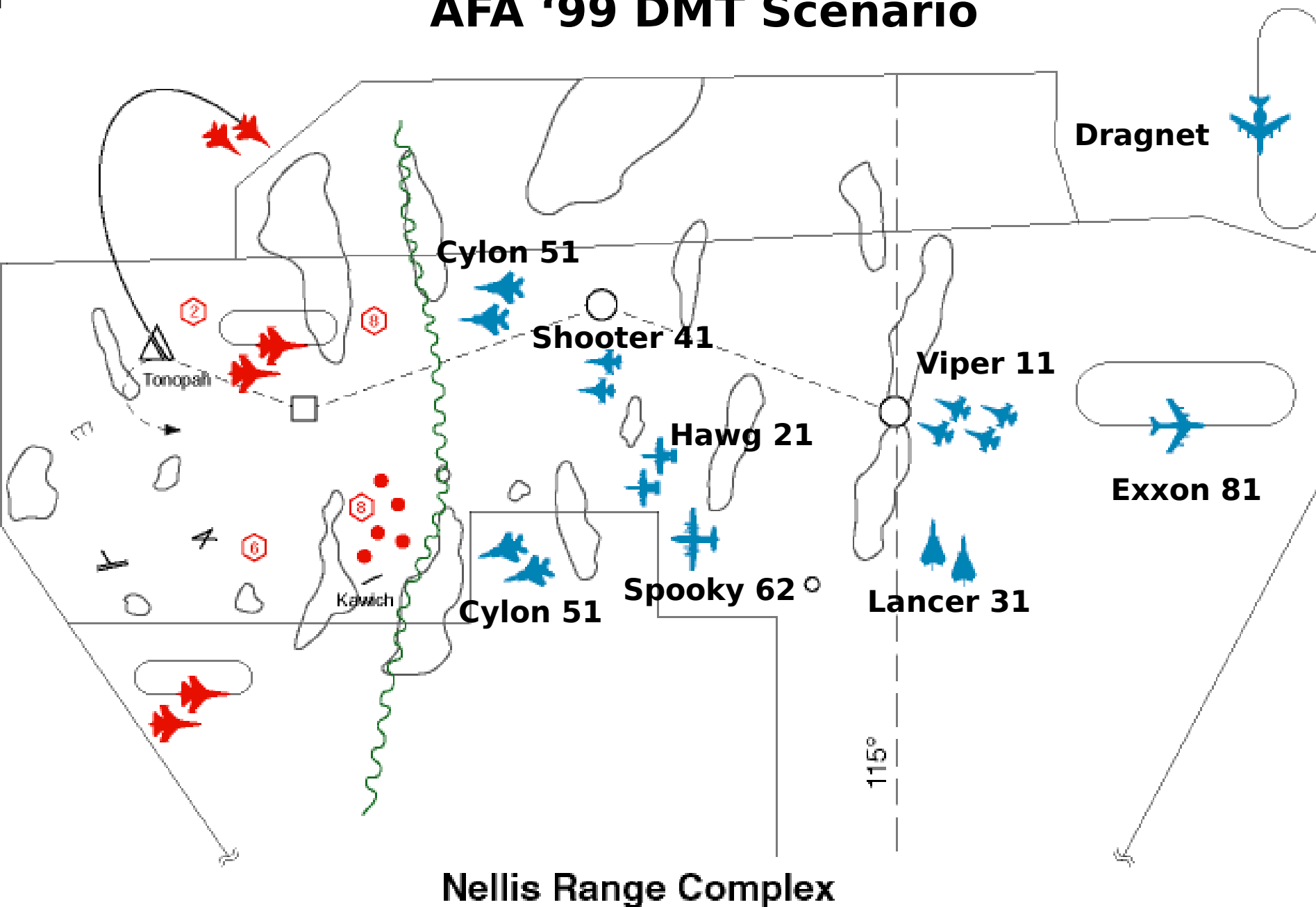
UAV MTT Sim (Lab)

4,125 sq. ft. Display

AFA Convention '99
DMT Technology Demonstration Players

- **AFRL AFA Wash DC Site** 1
  Exercise Control
  - Virtual Sims
    - Two F-16C
  2
  - STOW Synthetic Forces
    - Two F-16CJ, Four F-15C
  6
  - ATES:
    - One KC-135
    - One E-3B AWACS
  8
    - Two MiG-29 Fulcrum
    - Four SU-27 Flanker
  8
  - MODSAF: 8 T-72 Tanks
  - Night Vision Tng System (NVTS)
  - UAV
- **AFRL Mesa, AZ Site** 2
  National/International Network
  - Virtual Sims
    - Two F-16C
    - One A-10A
  3
- **355th Wing Davis Monthan AFB, AZ**
  - One A-10A UTD Virtual Sim
  3
- 1 **19th Special Ops Sq, Hurlburt AFB, FL**
  4
  1 - One AC-130U Virtual Sim

- **Thomson Training & Simulation**
  Crawley, United Kingdom (London)
  - Two RAF Tornados Virtual Sims
- **AFRL Brooks AFB, TX** 5
  1 - AWACS Weapons Director Virtual Sim
- **AFIWC Kelly AFB, TX** 6
  Integrated Air Defense System (IADS)
  - Constructive Forces
    - One SA-2 SAM
    - One SA-6 SAM
  5
    - One SA-8 SAM
    - Height Finding Radar
    - Early Warning Radar
- **TSMO, Huntsville, AL (AFA Site)** 7
  Threat Simulation Mgmt Office, US Army
  2 STRICOM
    - One SA-6 SAM
    - One SA-8 SAM
  8
- **TACCSF Kirtland AFB, NM**
  Network Pass Through 9
- **Theater Battle Arena**
  Pentagon, Washington, DC
  - Viewport

37 Virtual & Constructive entities, 9 different sit

AFA '99 DMT Scenario

Dragnet

Cylon 51

Shooter 41

Viper 11

Tonopah

Hawg 21

Exxon 81

Kawich

Cylon 51

Spooky 62

Lancer 31

115°

Nellis Range Complex

Summary

- **DMT is:**
  - **The connectivity for the Global Battlespace**
  - **An Air Force Readiness Initiative**
  - **The Next Generation in U. S. Air Force Readiness Training**
- **The TIS is an essential guide for critical DMT technology research and development investment**
- **AFRL/HEA is focused on the right technologies to enable DMT**
- **AFRL/HEA is engaged with industry, academia, other lab divisions, other services, and most importantly… the user!**

"Real-time Training - One Byte at a Time"